11. SCREENING OF ALTERNATIVES

This section discusses screening of remedial alternatives identified for OU 4-13 sites in the preceding section. In accordance with the CERCLA RI/FS guidance (EPA 1988), each remedial alternative identified in Section 8 is evaluated against three general criteria: effectiveness, implementability, and cost. A description of each screening criterion follows:

- **Effectiveness**—Effectiveness is the most important aspect of the screening evaluation. This criterion is used to assess how well an alternative would provide both short-term and long-term protection of human health and the environment, including how well the alternative would meet RAOs. In this context, short-term refers to the implementation period and long-term refers to the period thereafter. Also included, as a measure of effectiveness, is the ability to reduce the toxicity, mobility, and volume of the contaminated material.

- **Implementability**—This criterion is used to assess the technical and administrative feasibility of implementing an alternative. Technical feasibility includes the construction, operation, and maintenance required to implement the remedial action. Administrative feasibility includes the regulatory and public acceptance, availability of services, and specialized equipment and personnel requirements. Short-term implementability refers to the implementation period and long-term refers to the operation, maintenance, and institutional control period thereafter.

- **Cost**—This criterion is used to assess the relative magnitude of capital and operating costs for an alternative during the specified period of active control. Short-term cost refers to the implementation period and long-term refers to the operation, maintenance, and institutional control period thereafter.

Detailed descriptions of these criteria are given in the guidance for conducting feasibility studies under CERCLA (EPA 1988).

A description of each alternative developed for each site or site grouping in Section 10 is provided in order to evaluate effectiveness, implementability, and cost. These descriptions are intended to provide sufficient detail to distinguish between alternatives relative to the three screening criteria. Each description provides general information regarding the technologies comprising of an alternative and the applicability of those technologies to the conditions at the OU 4-13 site groups. The following subsections provide a description of each alternative and an evaluation based on the three screening criteria.

11.1 Alternative 1: No Action With Monitoring

11.1.1 Description

This alternative could be applied to any OU 4-13 site. The NCP [40 CFR 300.430 (e)(6)] requires consideration of a No Action alternative to serve as a baseline for evaluating other remedial alternatives. No land-use restrictions, controls, or active remedial measures would be implemented at the site. Risk levels would be reduced only through radioactive decay or other natural processes. Environmental monitoring can be considered part of a No Action alternative during the time the DOE has institutional control of the INEEL, which includes the site operational period and at least 100 years following site closure. The No Action with Monitoring alternative would therefore only be selected for sites where

contamination does not exceed unacceptable risk levels, and where the alternative would comply with ARARs.

Environmental monitoring would be performed to detect contaminant migration and to identify exposures via soil and groundwater. Monitoring results would be used to determine the need for any future remedial actions necessary to protect human health and the environment. Monitoring would be conducted until future reviews determine that further monitoring is not required. Radiation surveys would be performed at sites where contaminated soil and sediments remain in place as part of this remedial action until WAG-wide comprehensive environmental monitoring programs are implemented. Five-year reviews are included, as required under the NCP.

11.1.2 Evaluation

The No Action with Monitoring alternative would be easily implemented at all sites at moderate costs. However, results of the BRA indicate that OU 4-13 sites of concern present unacceptable risks to human health and the environment and therefore the No Action with Monitoring alternative is ineffective and does not meet RAOs. Long-term monitoring costs would be relatively low. Estimated costs for the No Action with Monitoring alternative for each site are provided in Table 11-1. Detail and summary sheets are provided in Appendix M.

11.2 Alternative 2: Institutional Control

11.2.1 Description

This alternative could be applied to any OU 4-13 site. Alternative 2 consists of the following actions to protect human health and the environment from potential risks associated with OU 4-13 sites:

- Surface water diversion
- Access restrictions
- Long-term environmental monitoring as for the No Action with Monitoring alternative
- Deed restrictions to be implemented if the property were ever transferred to non-federal ownership
- Five-year reviews.

Surface water diversion measures would be used to prevent ponding on the sites. Contour grading, drainage ditches, and other appropriate measures would be used to direct surface water away from the sites to existing natural or engineered drainage as required.

Access to the INEEL is currently restricted to ensure security and public safety. Since the OU 4-13 sites are located within the boundaries of the INEEL, Site-wide access restrictions would limit accessibility for at least 100 years. In addition, existing fences surrounding OU 4-13 sites would be maintained and replaced as necessary. Installing additional fences or relocating existing fences might also be necessary. Other access control measures may include (but are not limited to) warning signs, assessing trespassing fines, and establishing training requirements for persons allowed access. Land-use restrictions may be specified in the event that government control of the INEEL is not maintained throughout the institutional control period.

Table 11-1. Net present value of capital, operating and maintenance, and total costs for OU 4-13 remedial alternatives.

Site	Alternative 1: No Action with Monitoring	Alternative 2: Institutional Controls	Alternative 3a: Excavate, Treat and ICDF Dispose/Institutional Controls	Alternative 3b: Excavate, Treat and Off-INEEL Dispose/Institutional Controls	Alternative 4: Containment with ET-Type Cap and Institutional Controls
CFA-04					
Capital	881,000	1,398,000	6,732,000	12,636,000	4,830,000
O&M	229,000	3,101,000	229,000	229,000	3,162,000
Total	1,110,000	4,499,000	6,961,000	12,865,000	7,992,000
CFA-08					
Capital	881,000	1,440,000	30,756,000	36,549,000	6,508,000
O&M	229,000	3,420,000	229,000	229,000	3,486,000
Total	1,110,000	4,860,000	30,985,000	36,778,000	9,994,000
CFA-10					
Capital	881,000	1,245,000	1,380,000	1,442,000	2,145,000
O&M	0	2,664,000	0	0	2,715,000
Total	881,000	3,909,000	1,380,000	1,442,000	4,860,000

Site inspections, fence maintenance, and surface drainage would be implemented. Monitoring and inspection results would be considered during 5-year reviews to determine if active remediation was required at specific sites. Deed restrictions would be used to limit future uses of the property, if it were ever transferred to nongovernmental ownership.

11.2.2 Evaluation

The Institutional Control alternative is considered to be easily implemented for the institutional control period, since the specified actions would essentially continue existing management practices at the OU 4-13 sites. Worker protection measures including ALARA currently implemented under DOE orders will remain effective for the duration of occupational activities. Soil monitoring would be performed, as for the No Action with Monitoring alternative. Site inspections were assumed to be performed twice yearly, while soil cover maintenance, surface water diversion, and fence maintenance would be performed only on an as-needed basis. These controls are considered to be effective for protecting human health during the 100-year period of institutional control.

Risks to human health will remain at unacceptable levels after 100 years at all sites of concern, and ecological risks at CFA-04 and -10 will also remain at unacceptable levels. Ecological risks at CFA-04 and -10 would not be significantly reduced by institutional controls or deed restrictions. The Institutional Control alternative is therefore considered to meet RAOs for future residents, but not for protection of the environment, at OU 4-13 sites. This alternative is screened from further consideration for CFA-04 and -10, because it does not meet the ecological risk RAO for those sites, but is retained for CFA-08.

11.3 Alternative 3a: Conventional Excavation/Ex Situ Treatment/ICDF Disposal/Institutional Control

11.3.1 Description

This alternative could be applied to any OU 4-13 site. Details are provided for each site of concern, since COCs differ for each site.

11.3.1.1 CFA-04. COCs include mercury for human health risks, and copper and mercury for ecological risks. Soils would be characterized prior to excavation to the extent feasible to minimize the volume of soil excavated. Soils exceeding human health and/or ecological PRGs would be excavated, as described previously. Deed restrictions and 5-year reviews would be implemented where contamination above PRGs remained.

Excavated soils would be sampled and analyzed for TCLP. Based on sampling results, approximately 612 m^3 (800 yd^3) were assumed to fail TCLP for mercury, and total mercury concentrations measured are all below 260 mg/kg (low-mercury subcategory). RCRA-hazardous soils would be transported to the ICDF for stabilization in Portland cement and disposal. Non-hazardous soils above PRGs would be shipped to the ICDF and disposed of directly.

Following excavation and treatment, clean native fill soil would be trucked to the site and added to bring the level to grade, with a sloped surface to divert water. The site would be revegetated in accordance with INEEL guidelines. Five-year reviews and deed restrictions would be required if contamination above PRGs remained.

11.3.1.2 CFA-08. Human health risk COCs includes only Cs-137, and no ecological risks were identified. The treatment option for these soils and debris is screening, crushing and segmented gate

sorting on site to remove radionuclides contaminated at greater than the PRG of 23 pCi/g Cs-137. Soils contaminated at higher levels would be disposed of at the ICDF, while soils contaminated at lower levels would be returned to the excavation.

Following excavation and treatment, clean native fill soil would be trucked to the site and added to bring the level to grade, with a sloped surface to divert water. The site would be revegetated in accordance with INEEL guidelines. Deed restrictions and 5-year reviews would be implemented if contamination above PRGs remained.

If the SGS pilot-scale treatability study determines that the treatment is not cost-effective, then treatment would not be implemented and soils above PRGs would be disposed of directly at the ICDF.

11.3.1.3 CFA-10. Human health and ecological risk COCs include only Pb. Soil would be characterized prior to excavation to the extent feasible to minimize the volume of soil excavated. Excavated soils would be sampled and analyzed for TCLP, and for total Pb. The RCRA-hazardous soils would be transported to the ICDF for stabilization in Portland cement and disposal. Nonhazardous soils above PRGs would be shipped to the ICDF and disposed of directly. Based on 1998 RCRA characterization results, all CFA-10 soils are assumed to be hazardous. Soils with total lead concentrations less than PRGs would be returned to the excavation.

Following excavation and treatment, clean native fill soil would be trucked to the site and added to bring the level to grade, with a sloped surface to divert water. The site would be revegetated in accordance with INEEL guidelines. Institutional controls would not be required at CFA-10 after excavation and disposal, since all soil above PRGs would be excavated.

11.3.2 Evaluation

The short-term effectiveness of this alternative for protecting human health is moderate for all sites. Exposure of workers and environmental receptors to COCs during excavation, transportation, treatment, and disposal could be controlled using administrative and engineering controls including appropriate personal protection equipment (PPE), dust control, and other measures. The addition of treatment increases the potential for worker exposures, and the extent of controls required.

Long-term protection of human health and the environment is high. All COCs above allowable levels would be removed from the sites, immobilized, and disposed in a secure landfill, thereby eliminating all WAG 4 risk to human health and the environment above allowable levels. Institutional controls would ensure the long-term effectiveness of the remedy at any site where contamination above PRGs remained.

Technical and administrative implementability of this technology is considered moderate. Cement stabilization has been previously implemented at the INEEL, and segmented gate separation will be evaluated at pilot scale in 1999. However, treatment increases the overall complexity of the alternative, which reduces implementability. No long-term monitoring or care would be required at the sites, assuming all contamination was removed to a depth of 3 m (10 ft) bgs. However, deed restrictions and 5-year reviews would likely be required at CFA-04 and -08, where contamination above PRGs may remain at depths greater than 3 m (10 ft) bgs.

Short-term costs of the treatment process component of this alternative vary. Costs for stabilization in Portland cement and segmented gate separation are relatively moderate and low, respectively. Estimated capital and operating costs for Alternative 4a for each site are provided in Table 11-1.

11.4 Alternative 3b: Excavation/Treatment and Disposal Offsite/Institutional Controls

11.4.1 Description

This alternative could be applied to any OU 4-13 site. Details are provided for each site of concern, since COCs and exposure pathways differ.

11.4.1.1 CFA-04. The COCs include primarily mercury for human health risks, and copper and mercury for ecological risks. Soils would be characterized prior to excavation to the extent feasible to minimize the volume of soil excavated. Soils exceeding human health and ecological PRGs would be excavated, as described previously.

The CFA-04 disposal pond soils were determined to have radioactivity added by DOE activities (i.e., "rad-added"), based on analyzing 11 pond soil samples using DOE-ID technical procedure (TPR)-713. This method compares measured activities to a background envelope, established either as the 95% UCL of all measurements for a given set of samples; or by direct comparison to actual measured INEEL background values, cited in Appendix C, Table 1, of the procedure. The second method specifies distinctly different procedures for soil and other materials. The analysis identified Cs-137 as present in two samples, at activities greater than the 95% UCL and therefore defined as resulting from DOE activities[a]. However, measured activities are less than the actual measured INEEL background values and the soils may not be considered "rad-added" if this method had been used. The soils are assumed to be "rad-added" for purposes of this report until this issue is resolved.

Excavated soils would be sampled and analyzed for TCLP. Based on sampling results, approximately 612 m^3 (800 yd^3) were assumed to fail TCLP for mercury, and total mercury concentrations are all below 260 mg/kg (low-mercury subcategory). RCRA-hazardous soils exceeding PRGs would be shipped in bulk by rail to a representative MLLW TSDF, stabilized in Portland cement and disposed of there. Nonhazardous soils would be disposed of directly. Institutional controls, consisting of deed restrictions and 5-year reviews, were assumed to be required to ensure the long-term effectiveness of the remedy.

11.4.1.2 CFA-08. Human health risks COCs include only Cs-137 and no ecological risks were identified. The treatment option for these soils is onsite screening, crushing and segmented gate sorting to remove radionuclides contaminated at greater than the PRG of 23 pCi/g Cs-137. Soils contaminated at higher levels would be shipped in bulk by rail to a representative off-INEEL MLLW landfill for disposal there, while soils contaminated at lower levels would be returned to the excavation. Institutional controls, consisting of deed restrictions and 5-year reviews, were assumed to be required to ensure the long-term effectiveness of the remedy.

If the SGS pilot-scale treatability study determines that the treatment is not cost-effective, then treatment would not be implemented and soils above PRGs would be disposed of directly at the offsite facility.

11.4.1.3 CFA-10. Human health and ecological risk COCs include only Pb. Soils would be characterized prior to excavation to the extent feasible to minimize the volume of soil excavated.

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a. LMITCO Interdepartmental Communication TCS-025-98.

Excavated soils would be sampled and analyzed for TCLP, and for total Pb. All soils failing TCLP, and soils passing TCLP but exceeding lead PRGs, would be shipped in bulk by rail to Arlington, Oregon, stabilized in Portland cement, and disposed of there in a RCRA Subtitle C landfill.

All soils at CFA-10 (123 m^3 [161 yd^3]) were assumed to be treated as RCRA-hazardous, for cost estimating purposes for this alternative. Soils with lead concentrations below PRGs could be returned to the site.

Following excavation and treatment, clean native fill soil would be trucked to each site and added to bring the level to grade and establish a sloping final surface to divert surface water. The site would be revegetated in accordance with INEEL guidelines. Institutional controls were assumed to not be required.

11.4.2 Evaluation

The short-term effectiveness of this alternative for protecting human health is moderate for all sites. Exposure of workers and environmental receptors to COCs during excavation, transportation, treatment, and disposal could be controlled using administrative and engineering controls including appropriate PPE, dust control, and other measures. All treatment and disposal would be performed offsite, except for segmented gate separation for CFA-08, at dedicated facilities with established worker protection administrative and engineering controls.

Long-term protection of human health and the environment is also high. All COCs above allowable levels would be removed from the INEEL, immobilized, and disposed of in a secure landfill, thereby eliminating all risk to human health and the environment above allowable levels. Institutional controls would ensure the long-term effectiveness of the remedy at any site where contamination above PRGs remained.

Technical and administrative implementability of SGS treatment is considered high. Required offsite treatment and disposal services are available. Segmented gate separation will be evaluated at pilot scale at the INEEL in 1999. No long-term care would be required at the sites, assuming all contamination was removed.

Short-term costs of the treatment process component of this alternative vary. Costs for offsite stabilization in Portland cement, and onsite segmented gate separation are relatively moderate and low, respectively. No long-term monitoring costs would be required; assuming all contamination would be removed from all sites to depths of at least 3 m (10 ft) bgs. Estimated capital and operating costs for the removal, treatment, and disposal alternative for each site are provided in Table 11-1.

11.5 Alternative 4: Containment and Institutional Control

11.5.1 Description

This alternative could be applied to any OU 4-13 site. Alternative 4 consists of the following remedial actions to isolate contaminated soil at OU 4-13 disposal pond and buried soil contamination sites:

- Containment:
  - Evapotranspiration (ET)-type protective cover

- Institutional controls:
  - Long-term environmental monitoring as for the No Action with Monitoring alternative
  - Cover integrity monitoring and maintenance
  - Access restrictions
  - Surface water diversion
  - Deed restrictions
  - Five-year reviews.

Effectiveness of protective cover maintenance would be determined through monitoring. The protective cover would likely be monitored frequently during the first 6 to 12 months because potential problems (such as settling or subsidence) are most likely to occur within this period. After the initial 12 months, cover integrity monitoring may be performed annually or semiannually. Maintenance requirements include periodic removal of undesirable vegetation and burrowing animals and filling animal burrows. In addition, unacceptable erosion or subsidence would require repair of the affected area. Maintenance would be performed on an as-needed basis. Operations and maintenance goals would be defined during remedial design.

Environmental monitoring, cover integrity monitoring, access restrictions, and surface water diversion would be maintained at the contamination sites during the active institutional control period. Radiation surveys across and around CFA-08 would be performed to detect radionuclides mobilized by burrowing animals, erosion, or other natural processes. Cover integrity monitoring would be performed across and around all closed sites to assess maintenance requirements due to erosion, cracking, animal burrowing, or other observable deterioration of the cover. Access restrictions and surface water diversion measures would be implemented at all sites. Permanent warning markers would be placed on and around the cover. These institutional controls are assumed to remain effective for at least 100 years.

11.5.2 Functional requirements.

The ET -type cover is intended to meet the following functional requirements:

- Isolate waste for at least 500 to 1,000 years
- Minimize infiltration
- Minimum maintenance
- Inhibit inadvertent human intrusion and minimize plant and animal intrusion
- Protect surface water and groundwater.

The GWSCREEN calculations presented in the RI/BRA demonstrate that migration of contaminants from CFA sites to groundwater will not result in groundwater contamination in excess of risk-based levels. For purposes of this FS, groundwater protection is therefore assumed to not be a design

driver for the disposal ponds and buried contamination sites. However, any cover applied to CFA-04, -10, and -43 will likely be required to be functionally equivalent in infiltration control to a RCRA 3-layer cover, which can reduce infiltration rates to 1E-07 cm/sec, if not breached.

The ET-type cover design consists of four layers of natural media. This type of cap was specifically developed by DOE researchers to isolate low-level waste sites in arid climates, and exploits evapotranspiration demands that greatly exceed precipitation rates in the arid west. The materials used in each layer and the functions of each layer are described below, from the top down:

- The surface vegetation serves to remove water from the cap by transpiration. The rock mulch improves plant rooting by improving soil structure, and provides for additional wind and water erosion resistance. The grade of the surface serves to divert both precipitation and surface water run-on away from the waste site.

- The underlying native soil layer serves to store water, provide support for plants, and provides shielding from direct radiation.

- The biointrusion/capillary barrier, consisting of a layer of gravel overlying a layer of rock rip-rap or cobbles, serves two functions: (1) it provides a mechanical barrier to burrowing animals and an unfavorable medium for the advancement of plant roots and (2) it serves as a capillary break, acting to prevent infiltration downward until the overlying soil layer is saturated. This allows for storage during periods when the surface vegetation is inactive and evaporation rates are low.

- A bottom layer of impermeable asphalt, concrete or geosynthetic, if required for additional infiltration control.

- A foundation layer, serving to support the overlying cap.

Each component of the engineered cover (thickness of each layer, specifications of materials, etc.) would be evaluated and optimized during remedial design for application to the CFA sites.

Some RCRA landfill closure performance requirements could be considered relevant and appropriate for CFA-04 and -10, where RCRA hazardous wastes are present. These could include 40 CFR 264.310(a)(1-5) requirements that the cap:

- Provide long-term minimization of migration of liquids through the closed landfill

- Function with minimum maintenance

- Promote drainage and minimize erosion or abrasion of the cover

- Accommodate settling and subsidence so that the cover's integrity is maintained

- Have permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.

The 40 CFR 264.310 (b)(1,5,6) relevant and appropriate post-closure requirements could include:

- Maintain the integrity and effectiveness of the final cover, including making repairs to the cap as necessary to correct the effects of settling, subsidence, erosion, or other events
- Prevent runon and runoff from eroding or otherwise damaging the final cover
- Protect and maintain surveyed benchmarks.

11.5.3 Protective Cover Foundation

Preparing a stable foundation over the disposal ponds and buried contamination sites before constructing a protective cover would be essential to ensure long-term integrity. Subsidence could breach the integrity of any cover selected as a remedial action. Appropriate foundation preparation measures to prevent any differential settling that would result in subsequent failure of the proposed cover are therefore included.

Preparing the foundation for CFA-04 would initially require backfilling the pond. This action would consist of adding clean fill as required to bring the pond to grade.

Preparing the foundation of CFA-08 and -10 would initially require clearing and grubbing the sites, removing vegetation and potentially decontamination and decommissioning (D&D) and removal of any interfering structures. The D&D and structure removal are assumed to be completed before cover foundation construction would begin.

Disturbed soils would be compacted before capping. Currently, available methods for preparing foundations considered applicable to the disposal ponds and buried soil contamination sites include vehicle compaction methods such as a vibratory steel-wheel drum roller. Vehicle compaction would be performed concurrently with moisture addition, to achieve better compaction and prevent airborne dust. Alternatively, fill material could be placed over contaminated surface soil to prevent generation of airborne contamination prior to vehicle compaction. The most appropriate method of foundation preparation would be determined during the remedial design phase.

11.5.4 Shielding Requirements

Shielding requirements are discussed for CFA-08. INEEL soils and other geologic materials have previously been shown to readily attenuate Cs-137 dispersed in soil and debris. For purposes of this FS, shielding requirements developed for the WWP cells (DOE 1997) are assumed to be sufficient for all OU 4-13 sites, due to much higher activities in the WWP cells than present at any OU 4-13 sites. However, actual shielding requirements would be determined during remedial design.

The primary measure of effectiveness for the containment alternatives is the ability to satisfy the RAO of preventing exposure to penetrating radiation. Each cover design is therefore evaluated for the ability to provide sufficient shielding to reduce the dose rate from the surface of the site to background levels. Calculations provided in Appendix K of DOE (1997) determined that as little as 0.2 m (0.8 ft) total thickness of soil, and 0.2 m (0.6 ft) total thickness of cobbles, would reduce direct exposure risks to the 100-year resident to the 1E-04 level.

11.5.5 Evaluation

This alternative is considered to be highly effective in preventing long-term exposure to contaminated soils at OU 4-13 sites, and would effectively reduce surface exposures to background levels for the duration of risks. The cover is designed for long-term isolation with minimal maintenance requirements. The engineered cover specified for this alternative would likely be effective in preventing biointrusion. This cover also affords a high level of inadvertent intruder protection, by both the mass and impenetrability of material overlying contaminated soils. This type of cap was determined using hydrologic modeling to provide infiltration control approximately equivalent to a RCRA three-layer cap (Keck et al. 1992).

Installation of this cover is technically feasible. Short-term effectiveness for protecting human health and the environment is moderate to high, based on worker exposure during construction of the cover. The foundation layer would provide direct radiation protection of workers during construction of the overlying layers at CFA-08.

All aspects of this alternative are considered readily implementable. Construction services are available on site or locally. Soil, basalt cobbles, and gravels construction materials are available onsite, or could be obtained offsite locally. Long-term inspection and maintenance requirements would include reestablishing vegetation as necessary, repairing erosion furrows and animal burrows, and removing undesirable plants. Long-term monitoring requirements including visual inspections and radiation surveys would be easily implemented during the institutional control period. Estimated capital and operating costs for the Engineered Barrier Containment Alternative for each site are provided in Table 11-1.

11.6 Screening of Alternatives Summary

In the preceding subsections, each remedial action alternative was defined in order to provide sufficient qualitative information to allow differentiation among alternatives with respect to effectiveness, implementability, and cost. Results of these evaluations are now used for comparing alternatives within each general response action (GRA) relative to each other. Screening on a relative basis allows for either eliminating alternatives from further evaluation or retaining alternatives for detailed analysis. The purpose of this screening is to refine the list of alternatives to be retained for detailed analysis.

Alternatives may be screened from further consideration on the basis of relative effectiveness within a GRA or if an alternative is not considered implementable. An alternative can only be screened on the basis of cost when the relative effectiveness and implementability of other alternatives are equal. Alternatives can also be screened on the basis of unjustifiable cost relative to increased effectiveness or implementability. The screening process is only a preliminary evaluation, and alternatives are generally retained unless a clear basis for rejection is identified (EPA 1988).

11.6.1 Alternative 1: No Action With Monitoring

As required by the NCP, the No Action with Monitoring alternative is retained for detailed analysis to serve as the baseline for comparing other remedial action alternatives. Review of the BRA leads to the conclusion that "no action" is not an acceptable alternative on the basis of mitigation of identified human health and environmental risks greater than allowable levels.

11.6.2 Alternative 2: Institutional control

The Institutional Control alternative is considered to be effective for protecting human health during the 100-year period of institutional control, but would provide little or no reduction of environmental risks. Deed restrictions are assumed to effectively reduce human exposures to allowable levels indefinitely. This alternative is retained for further consideration only for CFA-08, where no ecological risks were identified.

11.6.3 Alternatives 3a and 3b: Removal/Treatment/ICDF Disposal and Removal/ Treatment/Off-INEEL Disposal/Institutional Controls

Both alternatives are retained for all sites. Short-term effectiveness is relatively similar between the two alternatives, while ICDF disposal is more technically implementable because of shorter transportation distance. Offsite disposal has higher long-term effectiveness, since all remediation waste would be removed from the INEEL; however, ICDF disposal is more cost-effective.

Stabilization in Portland cement could be performed either on- or off-INEEL. On-INEEL segmented gate sorting of radioactive soil is retained as a treatment option, pending INEEL pilot demonstration. If SGS treatment is not demonstrated to be cost-effective, then CFA-08 soils could be disposed of directly, either at the ICDF or offsite. Both on- and off-INEEL excavation, treatment and disposal alternatives are retained for detailed analysis for all sites.

11.6.4 Alternative 4: Containment and Institutional Control

Containment using an ET-type cover is considered to be effective in inhibiting exposures via direct radiation exposure, soil ingestion, homegrown produce ingestion, and ecological exposures at OU 4-13 soil contamination sites. This alternative is retained for further consideration at all sites.

11.6.5 Alternatives Retained for Further Analysis

The screening process identified alternatives with favorable composite evaluations of effectiveness, implementability, and cost. Based on the results of screening, the institutional control alternative (Alternative 2) is eliminated from further consideration for CFA-04 and -10, because ecological risks would not be reduced. The institutional control alternative is retained for CFA-08, where no ecological risks were identified, and where access and deed restrictions would limit human health risks for sufficient time for Cs-137 to decay to unrestricted release levels.

Excavation/treatment/disposal/institutional controls (Alternatives 3a and 3b) is retained for all sites. Containment and institutional controls (Alternative 4) using an ET-type cover is retained for all sites.

11.7 References

EPA, 1988, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA,* EPA/540/G-89/004, Interim Final, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, October.

Keck, J. F., 1992, *Evaluation of Engineered Barriers for Closure Cover of the RWMC SDA*, EDF # RWMC-523, January.

12. DETAILED ANALYSIS OF ALTERNATIVES

This section documents the detailed analysis of alternatives retained in the initial screening presented in Section 11. The detailed analysis provides the basis for identifying a preferred alternative for each site, and for preparing the proposed plan. After review of and comment on the RI/FS and the proposed plan, the detailed analysis will support the final selection of remedial actions for the OU 4-13 sites and preparation of the ROD.

12.1 Introduction

The FS detailed analysis assesses remedial action alternatives with respect to seven of the nine CERCLA evaluation criteria that can be addressed prior to public and agency comment. This analysis is more thorough and extensive than the initial screening presented in Section 11. The seven evaluation criteria form the basis for conducting the detailed analysis, which influence selection of an appropriate remedial action. The intent of this analysis is to present sufficient relevant information to allow decision-makers (i.e., DOE-ID, EPA, and IDHW) to select an appropriate remedy. Evaluation against all nine criteria, including public and state acceptance, is the basis for determining the ability of a remedial action alternative to satisfy CERCLA remedy selection requirements.

The detailed analysis is conducted in two distinct phases. Initially, alternatives are assessed individually against the evaluation criteria. Results of the individual analysis are then used in a relative or comparative analysis (second phase). This second analysis identifies advantages and disadvantages of the alternatives relative to one another, so that the key tradeoffs that decision-makers must balance can be identified.

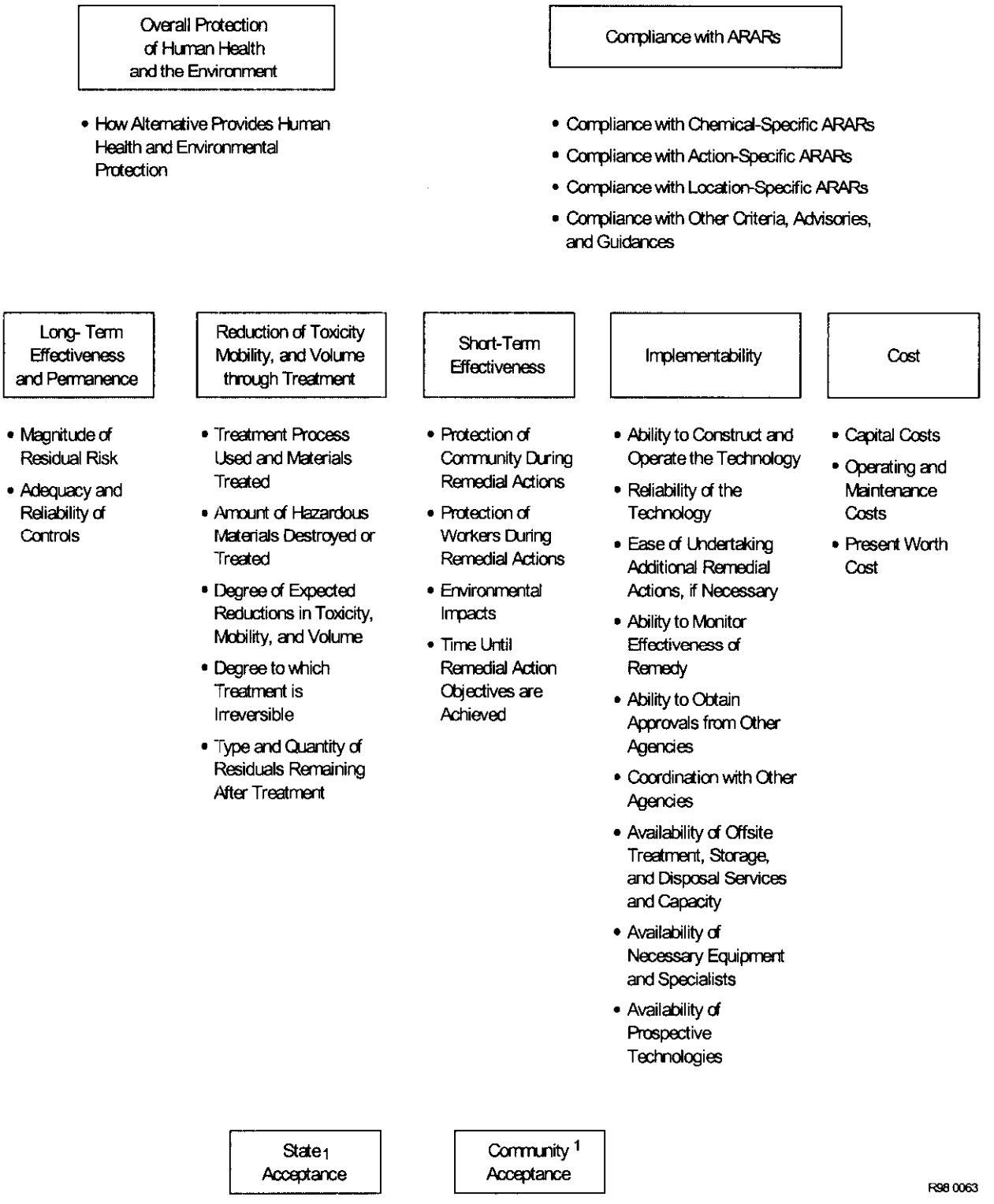
The process is depicted graphically in Figure 12-1. A description of each evaluation criterion outlined in 40 CFR 300.430(e)(9)(iii) is presented below.

12.1.1 Overall Protection of Human Health and the Environment

Alternatives shall be assessed to determine whether they can adequately protect human health and the environment, in both the short and long term, from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site by eliminating, reducing, or controlling exposures to levels established during the development of remediation goals consistent with 40 CFR 300.430(e)(2)(i). Overall protection of human health and the environment draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

12.1.2 Compliance with ARARs

The alternatives shall be assessed to determine whether they meet ARARs under federal environmental laws and state environmental or facility siting laws or provide grounds for invoking one of the waivers in 40 CFR 300.430(f)(1)(ii)(C).



[1]These criteria are assessed following comment on the RI/FS report and the proposed plan.

Figure 12-1. Criteria for detailed analysis of alternatives.

12.1.3 Long-term Effectiveness and Permanence

Alternatives shall be assessed for the long-term effectiveness and permanence they afford, along with the degree of certainty that the alternative would prove successful. Factors that shall be considered, as appropriate, include:

- Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities. The characteristics of residuals should be considered to the extent they remain hazardous, taking into account their volume, toxicity, mobility, and propensity to bioaccumulate.

- Adequacy and reliability of controls such as containment system and institutional controls that are necessary to manage treatment of residuals and untreated waste. This factor addresses, in particular, the uncertainties associated with land disposal for providing long-term protection from residuals; the assessment of the potential need to replace technical components of the alternative, such as a cap or treatment system; and the potential exposure pathways and risks posed should the remedial action need replacement.

12.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The degree to which the alternatives employ recycling or treatment that reduces toxicity, mobility, or volume shall be assessed, including how the treatment is used to address the principal threats posed by the site. Factors that shall be considered, as appropriate, include: (a) the treatment or recycling processes that the alternatives employ and the materials they will treat; (b) amount of hazardous substances, pollutants, or contaminants that will be destroyed or recycled; (c) degree of expected reduction in toxicity, mobility, or volume of the waste because of the treatment or recycling and the specification of which reductions are occurring; (d) degree to which the treatment is irreversible; (e) type and quantity of residuals that will remain following treatment, taking into consideration the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents; and (f) degree to which treatment reduces the inherent hazards posed by the principal threats at the site.

12.1.5 Short-term Effectiveness

The short-term impacts of the implementation period for each of the alternatives shall be assessed considering: (a) the short-term risks that might be posed to the community during implementation of an alternative, (b) potential impacts on workers during remedial action and the effectiveness and reliability of protective measures, (c) potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation, and (d) time until protection is achieved.

12.1.6 Implementability

The ease or difficulty of implementing the alternatives shall be assessed by considering the following types of factors, as appropriate: (a) technical feasibility, including the technical difficulties and unknowns associated with the construction and operation of the technology, reliability of the technology, ease of undertaking additional remedial actions, and ability to monitor the effectiveness of the remedy; (b) administrative feasibility, including activities required to coordinate with other offices and agencies and the ability and time needed to obtain any necessary approvals and permits from other agencies (for offsite actions); and (c) availability of services and materials, including the availability of adequate offsite treatment, storage capacity, and disposal capacity and services; availability of necessary equipment and

specialists, and provision to ensure any necessary additional resources; availability of services and materials; and (d) availability of prospective technologies.

12.1.7 Cost

The types of costs assessed include (a) FFA/CO management and oversight costs, which would be incurred primarily by the INEEL ER program; (b) cleanup costs, including construction management and oversight, RD/RA document preparation, and reporting costs; (c) remedial design costs; (d) construction costs, including General and Administrative (G&A) and construction subcontract fees; (e) operations costs; and (f) surveillance and monitoring costs. All initial and future life-cycle costs are normalized to present worth. Present worth is the cumulative worth of all costs, as of the beginning of the first year of activities, accounting for inflation of future costs. Present worth costs were estimated assuming variable annual inflation factors for the first 10 years, in accordance with LMITCO cost estimating procedures, and a constant 5% annual inflation rate after that. A constant 5% discount rate is assumed. Note that "present worth" is referred to as "net present value" in the Summary Cost Estimate Sheets provided in Appendix M, in accordance with LMITCO cost estimating procedures.

Total project cost in FY-98 dollars, and costs in escalated dollars are also presented. Total project cost in FY-98 dollars is the cost of performing all of the work today, without any inflation of costs for future work, while escalated dollars is the cost of performing all of the work accounting for inflation, but not discounted to present worth.

Note that in all cases the "Construction Subcontract" costs (i.e., the actual costs of construction) are much less than the present worth. Management and oversight, both by LMITCO and the construction contractor, account for a significant fraction of the total present worth in some cases. One hundred years of maintenance, surveillance, and monitoring also become a significant part of the present worth for those alternatives incorporating long-term maintenance and monitoring.

The alternative cost estimates are for comparison purposes only and are not intended for budgetary, planning, or funding purposes. Estimates have an estimated range of accuracy of +50 to -30%, in accordance with CERCLA (EPA 1988) guidance. The general methodology, assumptions, and derivations of alternative cost estimates are provided in Appendix M.

12.1.8 State Acceptance

State concerns regarding the RI/FS will be resolved before the proposed plan is issued for public comment.

The comment resolution report for the draft RI/FS report will be included with the final RI/FS report as an appendix.

12.1.9 Community Acceptance

This assessment includes determining which components of the alternatives interested persons in the community support, have reservations about, or oppose. The assessment of community acceptance will be completed through comments on the proposed plan.

Alternatives are not evaluated according to state and community acceptance during the detailed analysis. In accordance with CERCLA guidance, these final two criteria will be evaluated following comment on the RI/FS report and the proposed plan (EPA 1988). The two criteria will be addressed

during selection of a remedy and while the ROD is being prepared (EPA 1988). Responses to public comments will be included in the ROD Responsiveness Summary.

12.2 Individual Analysis of Alternatives

In accordance with CERCLA RI/FS guidance, remedial action alternatives retained for detailed analyses are individually assessed against the evaluation criteria listed above, not including state and community acceptance. The individual analysis of each alternative, from the perspective of WAG 4, is presented in the following subsections.

12.2.1 Alternative 1: No Action With Monitoring

The No Action with Monitoring alternative provides a baseline with which other alternatives can be compared, and could be applied to any OU 4-13 site. This alternative consists only of soil monitoring to assess conditions at OU 4-13 sites.

12.2.1.1 Overall Protection of Human Health and the Environment. Under the No Action with Monitoring alternative, human health and ecological risks at OU 4-13 sites would be the same as those identified in the BRA. The absence of controls for contaminated soils results in no reduction in long-term risks other than by natural radioactive decay. For purposes of this FS and in order to meet the intent of the NCP, it is assumed that under the No Action with Monitoring alternative, the sites could become immediately accessible to the general public. Human health and ecological RAOs would not be met at any of the sites of concern.

12.2.1.2 Compliance with ARARs and TBCs. Table 12-1 presents the evaluation of the No Action with Monitoring alternative for compliance with ARARs and to-be-considered (TBCs). While the No Action with Monitoring alternative does not involve any construction or operational activities that would result in disturbances to the surfaces of the OU 4-13 sites, IDAPA 16.01.01650 could nonetheless apply to any sites that were a source of fugitive dust and is therefore considered an ARAR that would not be met.

The DOE Order 5400.5 would not be met at CFA-08, because predicted health risks to current workers and potential future residents due to radionuclide exposures exceed allowable ranges. The 400 mg/kg soil lead cleanup level TBC would not be met at CFA-10, since lead would remain at concentrations above this level, with no administrative or engineering controls to prevent exposure.

12.2.1.3 Reduction of Toxicity, Mobility, or Volume through Treatment. No treatment is associated with this alternative.

12.2.1.4 Short-term Effectiveness. This alternative can be implemented immediately without additional risks to the community, workers, or the environment. No specialized equipment, personnel, or services are required to implement the No Action with Monitoring alternative.

12.2.1.5 Implementability. No implementation concerns are involved with the No Action with Monitoring alternative.

12.2.1.6 Costs. Estimated present worth costs for the No Action with Monitoring alternative for all sites are shown in Table 12-1. Postclosure costs were estimated for the full duration of the 100-year period of monitoring. The alternative cost estimates are for comparison purposes only and not intended for budgetary, planning, or funding.

Table 12-1. Evaluation of compliance with ARARs for the No Action with Monitoring alternative.

Statute	Citation	Evaluation		
		CFA-04	CFA-08	CFA-10
Action-specific				
Idaho Fugitive Dust Emissions	IDAPA 16.01.01.650	ARAR/No	ARAR/No	ARAR/No
NESHAPs for radionuclides from DOE facilities, emission monitoring, and emission compliance	40 CFR 61.92	ARAR/Yes	ARAR/Yes	Not ARAR
	40 CFR 61.93	ARAR/Yes	ARAR/Yes	Not ARAR
TBCs				
Limit of 100 mrem/yr EDE to public from exposures to external and internal radiation sources	DOE 5400.5	TBC/No	TBC/No	Not TBC
Limit of 10 mrem/yr EDE to the public from airborne doses	DOE 5400.5	TBC/No	TBC/No	Not TBC
400 mg/kg soil lead residential cleanup level	OSWER Directive 9355.4-12	Not TBC	Not TBC	TBC/No

12.2.2 Alternative 2: Institutional Control

This alternative would only meet RAOs for CFA-08, and is discussed only for that site.

12.2.2.1 Overall Protection of Human Health and the Environment. Under the Institutional Control alternative, human health risks at CFA-08 would be administratively controlled for the duration of risk. Long-term risks would be controlled by deed restrictions, and reduced to allowable levels by natural radioactive decay within 189 years.

Short-term protection of human health is high because no remedial actions would be implemented that could result in worker exposures. No ecological risks were identified at CFA-08.

12.2.2.2 Compliance with ARARs and TBCs. Table 12-2 presents the evaluation of the Institutional Control alternative for compliance with ARARs and TBCs. While the Institutional Control alternative does not involve any construction or operational activities that would result in disturbances to the surfaces of CFA-08, IDAPA 16.01.01650 could nonetheless apply to any sites that were a source of fugitive dust and is therefore considered an ARAR that would not be met. DOE Order 5400.5 would be met at CFA-08 by restricting public access.

12.2.2.3 Reduction of Toxicity, Mobility, or Volume through Treatment. No treatment is associated with this alternative.

12.2.2.4 Short-term Effectiveness. This alternative can be implemented immediately without additional risks to the community, workers, or the environment. No specialized equipment, personnel, or services are required to implement the Institutional Control alternative.

12.2.2.5 Implementability. No implementation concerns are involved with the Institutional Control alternative.

Table 12-2. Evaluation of compliance with ARARs for Alternative 2: Institutional Control-for CFA-08 only.

Statute	Citation	Evaluation
Action-specific		
Idaho Fugitive Dust Emissions	IDAPA 16.01.01.650	ARAR/No
NESHAPs for radionuclides from DOE facilities, emission monitoring, and emission compliance	40 CFR 61.92	ARAR/Yes
	40 CFR 61.93	ARAR/Yes
TBCs		
Limit of 100 mrem/yr EDE to public from exposures to external and internal radiation sources	DOE 5400.5	TBC/Yes
Limit of 10 mrem/yr EDE to the public from airborne doses	DOE 5400.5	TBC/Yes

12.2.2.6 Costs. Estimated present worth costs for the Institutional Control alternative for CFA-08 are shown in Table 11-1. Postclosure costs were estimated for the full duration of the 100-year period of monitoring. Costs for preparing deed restrictions are included, however long-term costs for maintaining them are not. The alternative cost estimates are for comparison purposes only, and are not intended for budgeting, planning, or funding estimates.

12.2.3 Alternative 3(a): Conventional Excavation/On-INEEL Treatment and ICDF Disposal/Institutional Controls

This alternative could be applied to any OU 4-13 site of concern. Aspects of the detailed analysis of Alternative 3a specific to individual sites are identified in the discussion below.

12.2.3.1 Overall Protection of Human Health and the Environment. This alternative would provide highly effective, long-term protection of human health and the environment. Removing soil contaminated above PRGs to a depth of 3 m (10 ft) bgs, and treating soil would eliminate potential long-term human health and ecological risks associated with future exposure to or migration of the contaminants, by eliminating the sources. Institutional controls would be implemented at any site where contamination above PRGs remained at depths greater than 3 m (10 ft) bgs, to ensure long-term effectiveness of the remedy.

This alternative is also environmentally protective during implementation, based on the engineering controls that would be used to prevent contaminant migration during excavation and treatment activities.

12.2.3.2 Compliance with ARARs and TBCs. Table 12-3 presents the evaluation of this alternative for compliance with ARARs and TBCs for each site. Performing excavation using air monitoring and dust suppression, as needed, would ensure compliance with the emissions control ARARs.

Table 12-3. Evaluation of ARARs and TBC compliance for Alternative 3a: Excavation/On-INEEL Treatment/ ICDF Disposal/Institutional Controls.

Statute (Subject)	Citation	Evaluation		
Action-specific		**CFA-04**	**CFA-08**	**CFA-10**
Idaho Fugitive Dust Emissions	IDAPA 16.01.01.650	ARAR/Yes	ARAR/Yes	ARAR/Yes
NESHAPs for radionuclides from DOE facilities, emission monitoring, and emission compliance	40 CFR 61.92	ARAR/Yes	ARAR/Yes	ARAR/Yes
	40 CFR 61.93 Subpart M-asbestos	ARAR/Yes	Not ARAR	Not ARAR
Hazardous Waste Determination	40 CFR 262.11	ARAR/Yes	ARAR/Yes	ARAR/Yes
Security	40 CFR 264.14	ARAR/Yes	Not ARAR	ARAR/Yes
Equipment Decontamination	40 CFR 264.114	ARAR/Yes	Not ARAR	ARAR/Yes
Use and Management of Containers	40 CFR 264 Subpart I	ARAR/Yes	Not ARAR	ARAR/Yes
Land Disposal Restrictions	40 CFR 268.40, .45, .48	ARAR/Yes	Not ARAR	ARAR/Yes
Miscellaneous Units	40 CFR 264.601, 264.602	ARAR/Yes	Not ARAR	Not ARAR
Chemical-specific				
Rules for the Control of Air Pollution in Idaho (.210-Demonstration of Preconstruction Compliance with Toxic Standards; .585-Toxic Air Pollutants Non-Carcinogenic Increments; .586-Toxic Air Pollutants Carcinogenic Increments)	IDAPA 16.01.01.210, 16.01.01.585 and 16.01.01.586	ARAR/Yes	ARAR/Yes	ARAR/Yes
TBCs				
Radioactive Waste Management (DOE low-level waste generation, characterization, acceptance criteria, treatment, shipment, disposal, QA, records and reports).	DOE 5820.2A, Chapter III(3)(c, d, e, f, g, i, l, m)	TBC/Yes	TBC/Yes	Not TBC
Radiation Protection of the Public and the Environment (Limit of 100 mrem/yr EDE to public from exposures to external and internal radiation sources.) (Limit of 10 mrem/yr EDE to the public from airborne doses.)	DOE 5400.5	TBC/Yes	TBC/Yes	Not TBC
400 mg/kg soil lead residential cleanup level	OSWER Directive 9355.4-12	Not TBC	Not TBC	TBC/Yes

All of the RCRA and IDAPA hazardous waste regulations would be met by characterizing, managing, treating and disposing of RCRA characteristic waste in accordance with all regulations. The LDRs would be met by complying with all applicable provisions of the restrictions. The treatment units would meet the 40 CFR 264.601 and 264.602 substantive requirements for performance standards, monitoring, analysis, inspection, response, and corrective action.

All applicable provisions of DOE orders would be met through the CERCLA RI/FS process. The 400-mg/kg soil lead cleanup level TBC would be met at CFA-10, since all soil contaminated with lead above this concentration would be removed. These alternatives are therefore considered capable of complying with all ARARs and TBCs identified.

12.2.3.3 Long-term Effectiveness and Permanence. This alternative would achieve long-term effectiveness and permanence because contaminated soil and debris would be completely removed from the sites. The long-term risk to human health and the environment would be transferred from WAG 4 to the ICDF. All residuals generated would be managed in accordance with ARARs.

The ICDF would provide secure storage of all contaminated soil from all sites. Institutional controls would ensure effectiveness of the remedy at any site where contamination above PRGs remained below 3 m (10 ft) bgs.

12.2.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment.

No reduction in toxicity or volume would result from chemical stabilization of CFA-10 D008 and CFA-04 D009 (low-mercury) soils. Volume increase would likely be in the range of 200% (Gering and Schwendiman 1996). Mobility of lead and mercury would be reduced by microencapsulation in the stabilized wasteform. This process is not irreversible, as water infiltrating through a degrading concrete wasteform could eventually leach mercury. However, the wasteform would likely remain intact for at least several hundred years. Relatively small quantities of secondary waste including decontamination fluids and personal protective equipment (PPE) would be produced.

Soil sorting using a segmented gate system would likely significantly reduce the volumes of CFA-08 soils disposed of in the ICDF, however actual reductions are site-specific and could only be determined during pilot testing. Over 99% volume reduction was reported for Cs-137 in high moisture content clay soils at the Savannah River Laboratory, which are considered difficult processing conditions. A separation efficiency of 90% was assumed for cost estimating purposes for this alternative. The total mass of Cs-137 that may be removed at CFA-08 using segmented gate separation was not estimated. Sorting would not reduce toxicity and mobility of Cs-137.

This treatment process is not considered irreversible, since the COCs would not be destroyed, and the toxicity of COCs would not be reduced. Residuals remaining after treatment would consist of clean soil, Cs-137 contaminated soil and relatively small quantities of equipment decontamination fluids and discarded PPE.

If segmented gate sorting is not found to be cost-effective for Cs-137-contaminated INEEL soils during pilot testing in 1999, then treatment would be eliminated from this alternative and CFA-08 soils would be disposed of directly.

12.2.3.5 Short-term Effectiveness. Any health risks to workers during excavation, removal and treatment of WAG 4 remediation waste could be effectively mitigated using standard administrative and engineering controls including dust suppression and appropriate PPE. Short-term effectiveness is

therefore assessed as moderate. Equipment operator exposures would be minimized to the extent possible. Excavation equipment modified with positive-pressure ventilation system cabs and HEPA filters for use in contaminated areas is available at the INEEL from previous remedial actions at the INEEL.

Environmental impacts for this alternative are minimal and are similar to those for the excavation and disposal alternative. No environmentally sensitive archaeological or historical sites, wetlands, or critical habitat exist at WAG 4.

The RAOs would be achieved by this alternative once excavation, treatment, ICDF disposal and implementation of institutional controls were complete. The estimated time required to perform the actual removal and treatment of contaminated soil at any site is less than 6 months. However, the estimated time to prepare environmental assessments, safety analyses, and design phases, as well as performing the removal, treatment and verification sampling is 18 to 24 months.

12.2.3.6 Implementability. Implementability of ICDF disposal is uncertain; otherwise this alternative is technically and administratively implementable. Chemical stabilization of lead and mercury have been previously performed onsite on INEEL soils. Potential vendors for chemical stabilization were identified (EPA 1998). Implementability of segmented gate sorting is considered moderate. Segmented gate separation of radionuclide-contaminated soils will be evaluated at pilot-scale at the ICPP in 1998.

12.2.3.7 Cost. The estimated cost for this alternative for each site is identified in Table 11-1. The alternative cost estimates are for comparison purposes only and not intended for budgetary, planning, or funding purposes.

12.2.4 Alternative 3(b): Conventional Excavation/Treatment and Off-INEEL Disposal/Institutional Controls.

This alternative could be applied to any OU 4-13 site of concern. Aspects of the detailed analysis of Alternative 3b specific to individual sites are identified in the discussion below. This alternative is sufficiently similar to Alternative 3a that only differences between the two are discussed.

12.2.4.1 Overall Protection of Human Health and the Environment. This alternative is essentially equivalent to Alternative 3a with respect to this criterion.

12.2.4.2 Compliance with ARARs and TBCs. Table 12-4 presents the evaluation of this alternative for compliance with ARARs and TBCs for each site. This alternative is essentially equivalent to Alternative 3a with respect to this criterion. This alternative is capable of complying with all of the ARARs and TBCs identified.

12.2.4.3 Long-term Effectiveness and Permanence. This alternative is essentially equivalent to Alternative 3a with respect to this criterion.

12.2.4.4 Reduction of Toxicity, Mobility, or Volume through Treatment. This alternative is essentially equivalent to Alternative 3a with respect to this criterion.

12.2.4.5 Short-term Effectiveness. This alternative is essentially equivalent to Alternative 3a with respect to this criterion.

Table 12-4. Evaluation of ARARs and TBC compliance for Alternative 3b: Excavation/Treatment/ Off-INEEL Disposal/Institutional Controls.

Statute (subject)	Citation	Evaluation		
Action-specific		**CFA-04**	**CFA-08**	**CFA-10**
Idaho Fugitive Dust Emissions	IDAPA 16.01.01.650	ARAR/Yes	ARAR/Yes	ARAR/Yes
NESHAPs for radionuclides from DOE facilities, emission monitoring, and emission compliance	40 CFR 61.92 40 CFR 61.93	ARAR/Yes	ARAR/Yes	ARAR/Yes
	Subpart M-asbestos	ARAR/Yes	Not ARAR	Not ARAR
Hazardous Waste Determination	40 CFR 262.11	ARAR/Yes	ARAR/Yes	ARAR/Yes
Equipment Decontamination	40 CFR 264.114	ARAR/Yes	Not ARAR	ARAR
Use and Management of Containers	40 CFR 264 Subpart I	ARAR/Yes	Not ARAR	ARAR/Yes
Land Disposal Restrictions	40 CFR 268.40, .45, .48	ARAR/Yes	Not ARAR	ARAR/Yes
Miscellaneous Units	40 CFR 264.601, 264.602	ARAR/Yes	Not ARAR	Not ARAR
Chemical-specific				
Rules for the Control of Air Pollution in Idaho (.210-Demonstration of Preconstruction Compliance with Toxic Standards; .585-Toxic Air Pollutants Non-Carcinogenic Increments; .586-Toxic Air Pollutants Carcinogenic Increments)	IDAPA 16.01.01.210, 16.01.01.585 and 16.01.01.586	ARAR/Yes	Not ARAR	Not ARAR
TBCs				
Radioactive Waste Management (DOE low level waste generation, characterization, acceptance criteria, treatment, shipment, disposal, QA, records and reports)	DOE 5820.2A, Chapter III(3)(c, d, e, f, g, i, l, m)	TBC/Yes	TBC/Yes	Not TBC
Radiation Protection of the Public and the Environment (Limit of 100 mrem/yr EDE to public from exposures to external and internal radiation sources) (Limit of 10 mrem/yr EDE to the public from airborne doses.)	DOE Order 5400.5	TBC/Yes	TBC/Yes	Not TBC
400 mg/kg soil lead residential cleanup level	OSWER Directive 9355.4-12	Not TBC	Not TBC	TBC/Yes

12.2.4.6 Implementability. Off-INEEL vendors for chemical stabilization and disposal of D008 and D009 MLLW and hazardous waste were identified. Segmented gate separation of radionuclide-contaminated soils will be evaluated at pilot-scale in 1999. Off-INEEL LLW disposal facilities were also identified.

12.2.4.7 Cost. The estimated cost for this alternative for each site is identified in Table 11-1. The cost analysis for this alternative assumes that no postclosure monitoring or care would be required at any site. The alternative cost estimates are for comparison purposes only and not intended for budgetary, planning, or funding purposes.

12.2.5 Alternative 4: Containment with Institutional Control

This alternative could be applied to any OU 4-13 site of concern. Aspects of the detailed analysis of Alternative 4 specific to individual sites are identified in the discussion below.

12.2.5.1 Overall Protection of Human Health and the Environment. This containment alternative includes institutional controls (radiation surveys, cap integrity monitoring, and access restrictions) and surface water diversion controls. Surface water diversion controls will be maintained at least until the 100-year institutional control period expires. The capped sites and surrounding areas would not accumulate standing water.

The ET-type barrier was designed to isolate low-level radioactive waste land disposal units from human intrusion, contaminant migration and biointrusion, and to provide direct radiation shielding, for 500 to 1,000 years. Some of the redundancy in the basic design was eliminated, since radionuclide risks at CFA-08 will decline to allowable levels within 189 years; and since groundwater protection is not an issue for OU 4-13 sites except for CFA-04 and -10, which are required to meet RCRA requirements. The resulting cover, combined with institutional controls and monitoring, is expected to be highly protective of human health and the environment, and to meet all RAOs, at all OU 4-13 soil release sites of concern.

The ET-type cover would ensure long-term protection by use of natural construction materials approximately 2.9 m (9.6 ft) thick. The thickness of this barrier would be more than sufficient to shield against direct radiation above background levels. The biobarrier component of this design would inhibit biointrusion, thereby protecting ecological receptors. Additionally, this barrier would inhibit inadvertent human intrusion, would divert surface water to perimeter drains, would promote lateral internal drainage and resist wind erosion. Short-term risks to workers and the environment during installation of the engineered cover are low to moderate.

12.2.5.2 Compliance with ARARs and TBCs. Table 12-5 presents the evaluation of the containment alternatives for compliance with ARARs and TBCs. Potential radionuclide and fugitive dust emissions during construction of protective covers at OU 4-13 sites would be controlled through air monitoring and use of dust control as needed. No emissions would be anticipated once a protective cover is in place. Activities associated with the containment alternatives would not constitute an emissions "source" and therefore do not trigger IDAPA 16.01.01.585-586 as an ARAR. The National Emissions Standards for Hazardous Air Pollutants (NESHAP) (40 CFR 61.90) is an ARAR for the containment alternatives, and would be met by eliminating all exposure pathways.

The RCRA-Hazardous Waste Determination rules (40 CFR 262.11) would apply to all sites. Specific provisions of 40 CFR 264.14 (Security) would be considered relevant and appropriate at CFA-04 and -10, and would be met by installing and maintaining signs and fences as needed. The 40 CFR 264.114, "Equipment Decontamination," would be relevant and appropriate and would be met.

Table 12-5. Evaluation of ARARs and TBCs compliance for Alternative 4: Containment and Institutional Controls.

Statute (subject)	Citation	Evaluation		
Action-specific		**CFA-04**	**CFA-08**	**CFA-10**
Idaho Fugitive Dust Emissions	IDAPA 16.01.01.650	ARAR/Yes	ARAR/Yes	ARAR/Yes
NESHAPs for radionuclides from DOE facilities, emission monitoring, and emission compliance	40 CFR 61.92 40 CFR 61.93	ARAR/Yes	ARAR/Yes	ARAR/Yes
	Subpart M-asbestos	ARAR/Yes	Not ARAR	Not ARAR
Hazardous Waste Determination	40 CFR 262.11	ARAR/Yes	ARAR/Yes	ARAR/Yes
Equipment Decontamination	40 CFR 264.114	ARAR/Yes	Not ARAR	ARAR/Yes
Closure and Post Closure	40 CFR 264.310(a)(1-5)	ARAR /Yes	Not ARAR	ARAR/Yes
	40 CFR 264.310(b)(1, 5, 6)			
Chemical-specific				
Rules for the Control of Air Pollution in Idaho	IDAPA 16.01.01.210,	ARAR/Yes	ARAR/Yes	ARAR/Yes
(.210-Demonstration of Preconstruction Compliance with Toxic Standards; .585-Toxic Air Pollutants Non-Carcinogenic Increments; .586-Toxic Air Pollutants Carcinogenic Increments)	16.01.01.585 and 16.01.01.586			
Location-specific				
None identified				
TBCs				
Radioactive Waste Management	DOE 5820.2A, Chapter III(3)(a)(1-3)	TBC/Yes	TBC/Yes	Not TBC
Radiation Protection of the Public and the Environment	DOE 5400.5	TBC/Yes	TBC/Yes	Not TBC
Limit of 100 mrem/yr EDE to public from exposures to external and internal radiation sources				
Limit of 10 mrem/yr EDE to the public from airborne doses				
400 mg/kg soil lead cleanup level	OSWER Directive 9355.4-12	Not TBC	Not TBC	TBC/Yes

The RCRA closure and postclosure rules related to closure cover design requirements and cover maintenance (40 CFR 264.310(a)(1-5)) would be relevant and appropriate for CFA-04 and -10, and would be met. These requirements include:

- Provide long-term minimization of the migration of liquids through the closed site
- Function with minimum maintenance
- Promote drainage and minimize erosion or abrasion of the final cover
- Accommodate settling and subsidence so that the cover's integrity is maintained
- Have permeability less than or equal to the permeability of any bottom liner system or natural subsoils present.

The ET-type cover would control infiltration by promoting surface and lateral internal drainage; and by storing infiltrating moisture in the upper vegetated layer, allowing for removal by evapotranspiration. Drainage through the cap would not occur until saturated conditions developed, which would be unlikely. All other ARARs would be met.

The RCRA regulations would not apply to CFA-08, where RCRA listed and/or characteristic wastes are not present. The LDRs would not apply for this alternative for any site, since no wastes would be excavated.

All applicable provisions of DOE orders would be met through the CERCLA RI/FS process, as described previously for Alternative 3. The 400 mg/kg soil lead cleanup level TBC would be met at CFA-10, since all soil contaminated with lead above this concentration would be capped, and the exposure pathway broken. This alternative is therefore considered capable of complying with all ARARs and TBCs identified.

12.2.5.3 Long-term Effectiveness and Permanence. Containment and institutional controls would eliminate the external exposure risk pathway associated with contaminated soils left in place at CFA-08. All other worker, residential and ecological exposure pathways including homegrown produce ingestion, soil ingestion, and biointrusion would also be eliminated by physically restricting access to waste. Cap integrity monitoring and radiation survey programs would be implemented annually for the first 5 years following completion of the cap. The need for further environmental monitoring would be evaluated and determined by the agencies during subsequent 5-year reviews.

The ET-type cap is designed to prevent direct radiation exposures; to inhibit COC exposures due to homegrown produce or soil ingestion; to resist biointrusion that may penetrate the contamination zone and mobilize contaminants in the food chain, or may facilitate erosion due to wind and surface water runoff, and to resist erosion by wind and surface water. The design life of the capping technologies specified for the containment alternatives will depend on the construction materials specified, number and thickness of layers required, sequence of those layers, and construction techniques. The long-term effectiveness and permanence required at OU 4-13 sites is equivalent to the duration of human health and ecological risks. External exposure risks due to Cs-137 calculated for CFA-08 decrease to 1E-04 in approximately 189 years. However, human health and ecological risks due to toxic metals at CFA-04 and -10 do not decrease with time. Long-term effectiveness and permanence required at CFA-04 and -10 is therefore estimated as indefinite, since human health and ecological risks due to toxic metals do not decrease over time.

The ET-type barrier design would provide a high level of biointrusion protection, as evidenced by field-scale studies of similar designs. The ET-type barrier would also provide infiltration control and diversion of precipitation and run-on, which are design requirements at CFA-04 and -10 where RCRA hazardous constituents would remain in place.

The long-term performance of this alternative is considered to be highly effective for controlling all exposure pathways at OU 4-13 soil release sites for 500 to 1,000 years, with minimal maintenance requirements. Cap integrity monitoring, as well as periodic removal of undesirable vegetation and burrowing animals (if necessary), would be performed during the institutional control period.

Erosion and human intrusion are the most likely causes of barrier failure resulting in external exposure to contaminated surface and buried soil. The physical size of the ET-type cover, the thickness of the upper soil layer, the vegetated gravel mulch surface and the coarse texture of the component layers specified in the design are considered to effectively resist erosion. Human intrusion through the cap would be prohibited by land use restrictions.

12.2.5.4 Reduction of Toxicity, Mobility, or Volume through Treatment. No treatment is associated with the containment alternatives.

12.2.5.5 Short-term Effectiveness. Direct radiation exposure of construction workers installing a protective cover would be minimized by first placing a foundation layer over Cs-137 contaminated soils at CFA-08. Emplacement of foundation material and the lowermost layer(s) of the cover would add additional shielding sufficient to eliminate subsequent exposure risks throughout the remainder of construction activities at CFA-08. Based on DOE Order 5480.11, construction activities would be performed in accordance with the ALARA approach to radiation protection.

Inhalation and ingestion risks due to toxic metals in soil at CFA-04 and -10 could be minimized by the use of appropriate PPE, engineering controls, and adherence to health and safety protocols.

Nonexposure risks to workers are also a consideration during construction of the barriers. These risks result primarily from physical construction hazards, such as vehicle accidents or personal injuries. These hazards can be minimized by implementation of appropriate health and safety measures for earth-moving construction activities.

All construction materials for the cap designs are available at the INEEL or within the surrounding communities. Shipment from distant offsite locations is not anticipated to be required. Therefore, no risks are associated with transportation of construction materials.

Environmental impacts resulting from excavation and construction activities would be minimal. Materials would be excavated, transported, and placed entirely within previously disturbed areas. Installation of surface water diversion controls at the sites might alter nearby terrain. However, the overall impact of these activities is not considered irreparable and would be unnoticeable in the long term. The remoteness of the site would prevent any impact to the surrounding communities during construction activities. No environmentally sensitive areas such as archaeological or historical sites, wetlands, or critical habitat exist in the immediate vicinity of the OU 4-13 sites, since all are in previously disturbed areas. All previously undisturbed sites affected by OU 4-13 remedial activities would be evaluated for archeological and ecological resource values prior to disturbance, and activities in sensitive areas would be modified as required to meet ARARs.

The RAOs would be achieved by a containment alternative once construction of the barrier is complete. Approximately 12 to 15 months is assumed for design, procurement, and equipment and personnel mobilization. For the purpose of this FS, and based upon construction schedules for the INEEL OU 5-05/6-01 caps, it is assumed that any barrier can be constructed over any OU 4-13 site within a 6-month period. Administrative, technical, and other personnel would be involved; in addition, approximately 5 to 20 construction workers would be required onsite during construction, depending on the size of the site.

12.2.5.6 Implementability. Institutional controls and surface water diversion controls are easily implementable for this alternative, based on the availability of monitoring, access restriction, and runoff-control technologies. Personnel specifically trained to work in radioactively contaminated areas are available in the communities surrounding the INEEL.

Any future remedial actions required after emplacement of a cover or barrier would be difficult to implement because of the large volume of materials that would be placed over the site. Access into the closed site would likely require complete removal of significant portions of the cover.

Monitoring the effectiveness of containment for preventing external exposure to contaminated surface soil would require only visual inspection to determine the integrity of the barrier. Since infiltration is not a concern, except for CFA-04 and -10, the containment of contaminated surface soil would be ensured as long as the barrier remained intact. However, regular radiation surveys at CFA-08, and cover inspections at all sites, would be performed as part of the institutional controls in order to verify containment. Postclosure monitoring schedules and duration would be addressed during the remedial design phase. Monitoring costs were developed using costs for similar activities at the INEEL provided by LMITCO soil monitoring personnel. Activities were estimated to include:

- Two yearly radiation surveys with a NaI detector around the perimeter and across the surface of the cap at CFA-08
- Two yearly visual inspections at all sites with subsequent maintenance as required
- Annual review
- Five-year review.

12.2.5.7 Cost. The cost estimate developed for this alternative is based on constructing the ET-type cover, installing surface water diversion controls, using monitoring equipment, conducting analyses, and postclosure maintenance and monitoring. The estimated present worth values for constructing and maintaining the engineered cover alternative at OU 4-13 soil release sites are shown in Table 11-1.

Postclosure costs were estimated for the full duration of the 100-year period of maintenance and monitoring. The alternative cost estimates are for comparison purposes only and are not intended for budgetary, planning, or funding purposes.

12.3 Comparative Analysis

The comparative analysis provides a measure of the relative performance of alternatives against each evaluation criterion. The purpose of this comparison is to identify the relative advantages and disadvantages associated with each alternative. The comparative analysis does not identify a preferred alternative, but provides sufficient information to enable this selection by the appropriate decision-makers

(DOE-ID, EPA, and IDHW). The following sections present the alternative comparisons relative to each evaluation criterion, from the perspective of WAG 4. Table 12-6 summarizes how each alternative satisfies the RAOs identified in Section 7.1. Table 12-7 provides a narrative description of the relative performance of each alternative for each evaluation criterion while Table 12-8 summarizes the relative ranking of alternatives.

12.3.1 Overall Protection of Human Health and the Environment

The primary measure of this criterion is the ability of an alternative to achieve RAOs for OU 4-13 sites. For CFA-04 and –10, Alternatives 3a/b (Excavation/Treatment/On- or Off-INEEL Disposal/Institutional Controls, respectively) would provide the most effective long-term protection of human health and the environment, because all contamination above risk-based levels would be removed from the sites to a depth of 3 m (10 ft) bgs, and from the WAG. From the perspective of the WAG, there is no difference in the degree of protection of human health and the environment afforded by Alternatives 3a and 3b. From the perspective of the INEEL, Alternative 3b is significantly more protective, since all waste above human health and ecological risk-based levels would be removed from the INEEL. Alternative 4 is regarded as least effective, since contaminants above PRGs would remain at the sites.

With respect to protection of human health for CFA-08, ex situ treatment would not significantly improve the effectiveness of the remedy relative to removal and disposal alone. Alternative 2 (Institutional Controls) would be least effective, since no engineering controls would be implemented to reduce risks. However, this alternative is still regarded as adequately protective.

For all sites, the containment alternative (Alternative 4) would meet human health and ecological risk RAOs, but is regarded as somewhat less effective than Alternatives 3a and 3b, since contaminants would remain in soils untreated. The ET cover design would provide adequate shielding from direct radiation exposure, and would control all ingestion pathways for human and environmental receptors. Monitoring and maintenance during the institutional control period would control all cover degradation processes, but no controls would be maintained after the end of institutional control. Five-year reviews would be required to ensure that either remedy was still effective, since contaminants would remain in place.

Alternative 1 (No Action with Monitoring) would not prevent exposures resulting in risks greater than 1E-04 or HIs greater than 1.0 at sites of concern. This alternative would not meet RAOs at any site, since current workers could be exposed to direct radiation and ingestion risks greater than allowable levels.

12.3.2 Compliance with ARARs

The relative ranking of alternatives with respect to compliance with ARARs is summarized in Table 12-8. For CFA-04 and -10, Alternatives 3a and 3b would best meet all ARARs, since all activities would be completed within approximately 24 months and contaminants would not remain at the sites at levels exceeding risk- or regulatory-based levels. No ARARs related to long-term monitoring or other activities would apply.

Table 12-6. Comparison of alternatives with RAOs.

Criteria	Alternative 1: No Action with Monitoring (all sites)	Alternative 2: Institutional Controls (CFA-08 only)	Alternative 3a: Excavate/ Treat/ICDF Disposal (all sites)	Alternative 3b: Excavate/ Off-INEEL Treatment and Disposal (all sites)	Alternative 4: Containment w/ET-type Cap (all sites)
RAOs for contaminated soil					
Inhibit exposure	No additional exposure prevention provided.	Eliminates potential exposure by restricting access for duration of risk	Eliminates potential exposure by removing contamination from site.	Eliminates potential exposure by removing contamination from site.	Exposure prevented by thick protective cover.
Inhibit ingestion	No additional ingestion prevention provided.	Eliminates potential exposure by restricting access for duration of risk	Eliminates potential ingestion by removing contamination from site.	Eliminates potential ingestion by removing contamination from site.	Ingestion prevented by isolating contamination beneath a protective cover.
Inhibit degradation of closure covers	No protection provided.	NA	NA	NA	Protection provided for 100-year institutional control period.
Inhibit exposures to ecological receptors	No additional control of environmental exposure to contaminated soil.	No ecological risks identified	Eliminates potential exposure by removing contamination from site.	Eliminates potential exposure by removing contamination from site.	Protection provided by isolating contamination beneath a protective cover.

Table 12-7. Detailed analysis summary for OU 4-13 sites.

Criteria	Alternative 1: No Action with Monitoring (All sites)	Alternative 2: Institutional Controls (CFA-08 only)	Alternative 3a: Excavate/treat/ ICDF Disposal (All sites)	Alternative 3b: Excavate/treat/ Off-INEEL Disposal (All sites)	Alternative 4: Containment w/ET-type Cover (All sites)
Overall Protection of Human Health and the Environment					
Human health protection	No reduction in risk.	Eliminates potential exposure by restricting access for duration of risk	Eliminates potential exposure from contaminated soil at site by completely removing contamination from WAG 4. From WAG 4 perspective, no additional protection afforded by treatment.	Eliminates potential exposure from contaminated soil at site by completely removing contamination from WAG 4. From WAG 4 perspective, no additional protection afforded by treatment.	Cap would prevent exposure to contaminated soil and debris for 500–1,000 years.
Environmental protection	Allows continued ecological exposures.	No ecological risk identified for CFA-08	Eliminates potential ecological exposures by completely removing contamination from site. From WAG 4 perspective, no additional ecological protection afforded by treatment.	Eliminates potential ecological exposures by completely removing contamination from site. From WAG 4 perspective, no additional ecological protection afforded by treatment.	Cap would prevent exposure to contaminated soil and debris for 500–1,000 years.
Idaho Fugitive Dust Emissions-IDAPA 16.01.01650 et seq.	Would not meet ARAR because no controls would be implemented	Would not meet ARAR because no controls would be implemented	Would meet ARAR by eliminating potential for windblown soil contamination.	Would meet ARAR by eliminating potential for windblown soil contamination.	Would meet ARAR by eliminating potential for windblown soil contamination.
NESHAPS-40 CFR 61.92	NA	NA	Would meet ARAR by eliminating all exposure pathways.	Would meet ARAR by eliminating all significant exposure pathways.	Would meet ARAR by controlling all exposure pathways.
Hazardous Waste Determination-40 CFR 262.11	NA	NA	Would meet ARAR.	Would meet ARAR.	Would meet ARAR.
Security-40 CFR 264.14	NA	NA	NA	NA	Would meet ARAR for CFA-04 and -10; not ARAR for CFA-08.
Equipment Decontamination-40 CFR 264.114	NA	NA	Would meet ARAR for CFA-04 and -10; not ARAR for CFA-08.	Would meet ARAR for CFA-04 and -10; not ARAR for CFA-08.	Would meet ARAR for CFA-04 and -10; not ARAR for CFA-08.
Closure and Post-Closure-40 CFR 264.310(a)(1-5), 264.310(b)(1,5,6)	NA	NA	NA	NA	Would meet ARAR for CFA-04 and -10; not ARAR for CFA-08.
Use and Management of Containers-40 CFR 264 Subpart I	NA	NA	ARAR-would be met for CFA-04 and -10; not ARAR for CFA-08.	ARAR-would be met for CFA-04 and -10; not ARAR for CFA-08.	NA

Table 12-7. (continued).

Criteria	Alternative 1: No Action with Monitoring (All sites)	Alternative 2: Institutional Controls (CFA-08 only)	Alternative 3a: Excavate/treat/ ICDF Disposal (All sites)	Alternative 3b: Excavate/treat/ Off-INEEL Disposal (All sites)	Alternative 4: Containment w/ET-type Cover (All sites)
Miscellaneous Units – 40 CFR 264.601, 264.602	NA	NA	ARAR-would be met for CFA-04 and –10; not ARAR for CFA-08.	ARAR-would be met for CFA-04 and –10; not ARAR for CFA-08.	NA
Land Disposal Restrictions-40 CFR 268.40, .45, .48	NA	NA	ARAR-would be met for CFA-04 and –10; not ARAR for CFA-08.	ARAR-would be met for CFA-04 and –10; not ARAR for CFA-08.	NA
Rules for the Control of Air Pollution in Idaho-IDAPA 16.01.01.210, 16.01.01585 and 16.01.01586	NA	NA	ARAR-would meet through use of engineering controls.	ARAR-would meet through use of engineering controls.	ARAR-would meet through use of engineering controls.
Radioactive Waste Management-DOE 5820.2A	NA	Would meet TBC through administrative controls restricting access.	Would meet TBC through use of administrative and engineering controls. Not TBC for CFA-10.	Would meet TBC through use of administrative and engineering controls. Not TBC for CFA-10.	Would meet TBC through use of administrative and engineering controls. Not TBC for CFA-10.
Radiation Protection of the Public and Environment-DOE 5400.5	Would not meet TBC at CFA-04, -08 because no controls would be implemented. Not TBC for CFA-10.	Would meet TBC through administrative controls restricting access.	Would meet TBC through use of administrative and engineering controls. Not TBC for CFA-10.	Would meet TBC through use of administrative and engineering controls. Not TBC for CFA-10.	Would meet TBC through use of administrative and engineering controls. Not TBC for CFA-10.
Soil lead cleanup level-OSWER 9355.4-12	Not TBC for CFA-04, -08. Would not meet TBC for CFA-10	Not TBC	Not TBC for CFA-04, -08. Would meet TBC for CFA-10 by removing all soil above action levels.	Not TBC for CFA-04, -08. Would meet TBC for CFA-10 by removing all soil above action levels.	Not TBC for CFA-04, -08. Would meet TBC for CFA-10 by eliminating exposure pathway.
Magnitude of residual risk	No change from existing risks.	Risk eliminated by administrative controls on access.	Source-to-receptor pathways eliminated by removing source.	Source-to-receptor pathways eliminated by removing source.	Source-to-receptor pathways eliminated while cap remains in place.
Adequacy and reliability of controls	No control and, therefore, no reliability.	Reliable for duration of risk.	Disposal facility is assumed to provide adequate and reliable control over disposed soil and debris for the period of institutional controls.	Disposal facility is assumed to provide adequate and reliable control over disposed soil and debris for the period of institutional controls.	Barrier estimated to provide control over contaminated soil for at least 500-1,000 years.
Treatment process used	NA	NA	Chemical stabilization, segmented gate separation.	Chemical stabilization, segmented gate separation.	Not applicable.
Amount destroyed or treated	NA	NA	None destroyed; approximately 100% treated.	None destroyed; approximately 100% treated.	Not applicable.

Table 12-7. (continued).

Criteria	Alternative 1: No Action with Monitoring (All sites)	Alternative 2: Institutional Controls (CFA-08 only)	Alternative 3a: Excavate/treat/ ICDF Disposal (All sites)	Alternative 3b: Excavate/treat/ Off-INEEL Disposal (All sites)	Alternative 4: Containment w/ET-type Cover (All sites)
12-21 Reduction of toxicity, mobility, or volume	NA	NA	Segmented gate separation – greater than 90% volume reduction; chemical stabilization-200% volume increase. Greater than 90% mobility reduction. No reduction in COC toxicity.	Segmented gate separation –greater than 90% volume reduction; chemical stabilization-200% volume increase. Greater than 90% mobility reduction. No reduction in COC toxicity.	NA
Irreversible treatment	NA	NA	Chemical stabilization and segmented gate separation are not considered irreversible.	Chemical stabilization and segmented gate separation are not considered irreversible.	NA
Type and quantity of residuals remaining after treatment	NA	NA	Chemical stabilization-stabilized soils, decontamination fluids; discarded PPE. Segmented gate-contaminated soil, decontamination fluids, discarded PPE.	Chemical stabilization-stabilized soils, decontamination fluids; discarded PPE. Segmented gate-contaminated soil, decontamination fluids, discarded PPE.	NA
Statutory preference for treatment	Does not meet preference.	Does not meet preference	Meets preference.	Meets preference.	Does not meet preference.
Community protection	No increase in potential risks to the public.	No increase in potential risks to the public.	No increase in potential risks to public.	Slight increase in potential risks to the public during offsite transportation.	No increase in potential risks to the public.
Worker protection	Not applicable.	Workers protected by administrative controls	Workers protected by administrative and engineering controls.	Workers protected by administrative and engineering controls.	Workers protected by administrative and engineering controls.
12-21 Environmental impacts	No change from existing conditions.	No change from existing conditions.	Limited to disturbances from vehicle and material transport activities associated with excavation and transportation. Limited potential for airborne contamination in the form of fugitive dust, due to use of water sprays.	Limited to disturbances from vehicle and material transport activities associated with excavation and transportation. Limited potential for airborne contamination in the form of fugitive dust, due to use of water sprays.	Limited to disturbances from vehicle and material transport activities associated with barrier construction. Limited potential for airborne contamination in the form of fugitive dust, due to use of water sprays.
Time until action is complete	Not applicable.	Completed in 189 years, when Cs-137 levels at CFA-08 decay to unrestricted release criterion.	Approximately 18 to 24 months.	Approximately 18 to 24 months.	Approximately 18 to 24 months.

Table 12-7. (continued).

Criteria	Alternative 1: No Action with Monitoring (All sites)	Alternative 2: Institutional Controls (CFA-08 only)	Alternative 3a: Excavate/treat/ ICDF Disposal (All sites)	Alternative 3b: Excavate/treat/ Off-INEEL Disposal (All sites)	Alternative 4: Containment w/ET-type Cover (All sites)
Ability to construct and operate	No construction or operation.	No construction or operation.	ICDF status uncertain. Moderately difficult to construct and operate, involves available excavation and transportation equipment, specialized treatment equipment.	Moderately difficult, involves available excavation and transportation equipment, specialized treatment equipment.	Involves available construction technology.
Ease of implementing additional action if necessary	May require repeat of feasibility study/record of decision process.	Easy	Additional remedial action would not be necessary, as all contaminated soil and debris are removed.	Additional remedial action would not be necessary, as all contaminated soil and debris are removed.	Additional remedial actions would be difficult, as the barrier is intended to prevent access to contamination. Barrier would require removal.
Ability to monitor effectiveness	Monitoring of conditions is readily implemented.	Monitoring of conditions is readily implemented.	The effectiveness in removing all contaminated materials associated with site is easily monitored; effectiveness in treatment more difficult, requires confirmation sampling and analysis.	The effectiveness in removing all contaminated materials associated with site is easily monitored; effectiveness in treatment more difficult, requires confirmation sampling and analysis.	Barrier performance can be monitored through radiation surveys, can be visually assessed on the basis of physical integrity.
Ability to obtain approvals and coordinate with regulatory agencies	No approvals required.	No approvals required.	Moderately difficult.	Moderately difficult.	Moderately difficult.
Availability of services and capacity	None required.	None required.	Services available either onsite or through subcontractor. ICDF status uncertain, projected to exist on INEEL by 2001. Treatment services available through subcontractors	Services available either onsite or through subcontractor. Treatment and disposal capacity exists offsite.	Barrier design and services reside within the DOE and are considered readily available to INEEL.
12-22 Availability of equipment, specialists, and materials	None required	None required.	Equipment and materials are either available onsite, through subcontractors or will be purchased.	Equipment and materials are either available onsite, through subcontractors or will be purchased.	Equipment and materials are readily available at the INEEL or within the surrounding community.
Availability of technology	None required.	None required.	Readily available at the INEEL and/or through subcontractors.	Readily available at the INEEL and/or through subcontractors.	Readily available at the INEEL.
Costs	See Table 11-1	See Table 11-1	See Table 11-1	See Table 11-1	See Table 11-1

Table 12-8. Relative ranking of OU 4-13 site grouping remedial alternatives with respect to CERCLA evaluation criteria.[a]

Evaluation Criteria	Radionuclide-Contaminated Site (CFA-08)	RCRA Hazardous Waste Sites (CFA-04, -10)[1]
Overall protection of human health and the environment	(3a, 3b), 4, 2 **1 does not meet the criterion**	(3a, 3b), 4 **1 does not meet the criterion**
Compliance with ARARs	2, (3a, 3b), 4 **1 does not meet the criterion**	(3a, 3b), 4 **1 does not meet the criterion**
Long-term effectiveness and permanence	(3a, 3b), 4, 2, 1	(3a, 3b), 4, 1
Reduction of toxicity, mobility or volume through treatment	(3a, 3b), (4, 1, 2)	(3a, 3b), (4, 1)
Short-term effectiveness	1, 2, 4, (3a, 3b)	1, 4, (3a, 3b)
Implementability	1, 2, 4, 3a, 3b	1, 4, 3a, 3b
Cost	1, 2, 4, 3a, 3b	CFA-04: 1, 3a,4, 3b CFA-10: 1, 3a, 3b, 2, 4

a. Ranking is from highest to lowest, except for costs, which are ranked from lowest to highest in net present value.

( ) = No significant difference between alternatives with respect to the criterion.

Alternative 1: No Action With Monitoring.

Alternative 2: Institutional Controls

Alternative 3a: Excavate, Treat, and ICDF Disposal and Institutional Controls.

Alternative 3b: Excavate, Treat and Off-INEEL Landfill Disposal and Institutional Controls

Alternative 4: Containment with ET-Type Cover.

For CFA-08, Alternative 2 would best meet ARARs, since no active remediation would be implemented. Containment (Alternative 4) would meet ARARs least effectively at all sites, since active management would be required during the institutional control period to meet RCRA requirements at CFA-04 and -10; and DOE Orders at CFA-08.

Alternative 1 (No Action with Monitoring) would not involve construction or operation activities, therefore ARARs specific to these activities would not apply. However, IDAPA 16.01.01.650, the Fugitive Dust Control ARAR, could apply to OU 4-13 sites, regardless of whether or not remedial construction and/or operations occur, and would not be met by the No Action with Monitoring alternative. If toxic metals or organics were present in the fugitive dust, then IDAPA 16.01.01.210, 16.01.01.585 and 16.01.01.586 are ARARs that would not be met because no controls would be implemented.

The DOE orders limiting exposures to workers and hypothetical future residents would not be met in the absence of controls at CFA-08. The OSWER Directive for lead cleanup level would not be met for CFA-10.

12.3.3 Long-term Effectiveness and Permanence

Alternatives 3a and 3b would provide equivalent high long-term effectiveness and permanence, because contaminated soil and debris would be removed from the WAG. No long-term reliance on engineering or administrative controls would be required at the individual sites if all soil contaminated above PRGs was removed.

Alternative 4 would be less effective and permanent, and would also require monitoring, maintenance, and 5-year reviews during the institutional control period. Alternative 1 (No Action with Monitoring) would provide the least possible level of long-term effectiveness and permanence, based on the residual risk associated with OU 4-13 sites identified in the BRA.

For CFA-08, Alternative 2 would be less effective than Alternative 4, since no engineering controls on exposures would be implemented. However, the institutional controls that would be implemented are regarded as adequately protective.

12.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Only Alternatives 3a and 3b would apply treatment to contaminated OU 4-13 soils, therefore these alternatives have the highest rating with respect to this criterion. Alternatives 3a and 3b would reduce mobility and/or volume, however toxicity of radionuclides and metals would not be reduced. Volume could potentially be reduced by as much as 90% for segmented gate soil sorting, however mobility would not be reduced. Stabilizing soils in Portland cement would increase volumes of contaminated material by as much as 200%. Mobility would be eliminated completely through stabilization in Portland cement, assuming the process was carefully implemented and monitored.

Alternatives 1, 2 and 4 are equivalent with respect to this criterion, since no treatment would be implemented.

12.3.5 Short-term Effectiveness

Alternative 1 (No Action with Monitoring) would be the most effective alternative in the short-term at all sites, since no actions resulting in additional worker exposures would occur. None of the OU 4-13 sites are located near inhabited areas and no public roads are in the vicinity, therefore no offsite exposures would occur. No additional environmental impacts would result from this alternative other than the conditions already existing. Potential contaminant migration from surface soil exists in the form of wind and water erosion. As noted previously, the BRA indicates that the No Action with Monitoring alternative would not meet RAOs, due to existing worker and ecological risks.

For CFA-08, Alternative 2 would provide the highest short-term effectiveness, since no active remediation would be implemented that could result in worker exposures.

Alternative 4 would provide effective short-term protection at all sites. Exposure risks to workers during cover construction would be minimal. Personal protective equipment and adherence to health and safety protocols would minimize exposures during consolidation activities. Initial foundation layers would likely provide sufficient shielding to reduce direct exposure to workers to acceptable levels.

Ecological impacts resulting from excavation of cover materials including soil, basalt, gravel, and cobbles would be assumed to be minimal, since previously utilized sources for all of these materials exist on the INEEL. The RAOs would be achieved with the containment alternatives after cover construction

was complete. Fill material placed as a cap foundation would prevent contaminant migration to the surrounding environment in addition to providing shielding for workers.

Alternatives 3a and 3b would be less effective for short-term protection for CFA-08. The risk to workers resulting from direct exposure to the contaminated soil and debris is considered significant. Environment impacts would be minimized by maintaining dust suppression controls during excavation, treatment and transportation. Additionally, some increase in potential risk to the public from exposure to contaminated materials, in the event of a transportation accident, would likely result.

The relative ranking of the alternatives with respect to short-term effectiveness is shown in Table 12-8.

12.3.6 Implementability

Alternative 1 (No Action with Monitoring) would be most implementable for all sites, since it would require no change in existing site conditions. Alternative 2 would be very implementable for CFA-08, since no active remediation would be implemented and the only additional action required would be to implement deed restrictions. The containment alternative (Alternatives 4) design is relatively simple and has been constructed on the INEEL at pilot-scale.

Alternative 3a is more technically implementable than 3b, because of the shorter transportation distance. The individual treatment technologies specified for Alternatives 3a and 3b are available and have been demonstrated. Alternative 3a would require significantly more resources to perform environmental assessments, safety analyses, and permit applications than Alternative 3b. If the ICDF or other INEEL disposal facilities were not available, Alternatives 3b would be more implementable than Alternatives 3a.

The relative ranking of the alternatives with respect to implementability is shown in Table 12-8.

12.3.7 Cost

The relative ranking of the alternatives for all site groupings with respect to present worth cost is presented in ascending order in Table 12-8. The level of detail used to develop the cost estimates presented is considered appropriate for comparing alternatives. Separate cost line items are developed for the primary components of each remedial action alternative, such as monitoring; capping; excavation; disposal, and reporting requirements such as RD/RA scope of work, RD/RA work plans, safety documentation, and progress reports.

The level of detail presented in the cost estimates is consistent with the level of detail provided in the descriptions of each alternative. Additional details in the cost estimates are not considered appropriate without supporting detailed designs for each alternative. The uncertainty associated with each cost estimate increases with the complexity of the alternative.

The No Action alternative (Alternative 1) was estimated to be the least expensive for CFA-04. Containment onsite (Alternative 4) was estimated as more expensive, but not significantly so, than excavation/treatment/ICDF disposal (Alternative 3a) for CFA-04; while Alternative 4 was more expensive than any other alternative for CFA-10, reflecting economy of scale for capping. Excavation/treatment/offsite disposal (Alternative 3b) was significantly more expensive than any other alternative considered for CFA-04.

The No Action alternative (Alternative 1) was estimated to be the least expensive for CFA-08. Institutional control (Alternative 2) was estimated to be significantly less expensive than any other remedial alternative for CFA-08, while Containment (Alternative 4) was significantly less expensive than any other active remediation alternative considered for CFA-08. Excavation/treatment/ICDF disposal (Alternative 3a) was estimated as about three times more expensive than containment onsite. ICDF disposal (Alternative 3a) was estimated to be less expensive than offsite disposal (Alternative 3b).

12.4 Summary of the Comparative Analysis

In general, the contaminant types and site characteristics at OU 4-13 are similar to those encountered elsewhere on the INEEL. Remedial technologies and alternatives identified to control or eliminate risks to human health and the environment at OU 4-13 are those previously demonstrated at the INEEL, or under similar conditions elsewhere. The intent of the FS is to provide risk managers sufficient information on various technologies and alternatives to prepare the proposed plan and the ROD. Technologies used to formulate alternatives are regarded only as representative; risk managers may combine other technologies identified in this report as effective and technically implementable, to formulate different alternatives.

Human health risks at all sites will persist beyond the 100-year institutional control period; therefore, monitoring/institutional controls alone (Alternative 1) will not meet RAOs and does not meet the threshold criteria. Alternative 2 (Institutional Controls) is regarded as protective only for CFA-08, where no ecological risks were identified. Alternatives that would remove all soil contaminated above PRGs from the WAG (Alternatives 3a and 3b) are regarded as equivalent in providing highly effective protection of human health and the environment for all sites.

Alternatives incorporating ex situ treatment were not determined to provide significantly more long-term effectiveness and permanence, or protection of human health, than removal and disposal alone; and they are more expensive. Treatment would only be required for RCRA characteristic wastes excavated from CFA-04 and -10. Mobility and volume of radionuclides and toxic metals could be reduced through treatment; however, in general OU 4-13 contaminants are dispersed in soil and containment, either onsite or offsite, is appropriate, based on expectations for remedial actions cited in 40 CFR 300.430.

Institutional Control (Alternative 2) was identified as the least expensive alternative that would meet the threshold evaluation criteria for the largest OU 4-13 site, CFA-08. The long-term effectiveness and permanence of this alternative was estimated as adequate, but lower than combined engineering and administrative controls.

For CFA-04 and -10, excavation, treatment and ICDF disposal (Alternative 3a) was estimated as the least expensive alternative that would meet the threshold criteria.

12.5 References

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